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Low Seabird Densities in the Pelagic Environment of the Strait of Georgia, British Columbia[1]

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ABSTRACT: Seabird surveys in the pelagic environment of the Strait of Georgia, British Columbia, indicated an exceptionally low annual average density of 3.16 seabirds per km^2 when compared to similar estimates of seabird densities in other south coastal British Columbia waters. In spite of a wide (20-km) pelagic zone the avifauna lacked most of the open ocean species and in fact was typical of the inshore protected waters of British Columbia. Two possible explanations were considered. First, though the biological productivity of the study area is not low the apparent absence of suitable foods, particularly adult Pacific herring, *Clupea harengus pallasii* (Valenciennes), may explain the low seabird numbers. Second, the discharge of the Fraser River which creates a highly turbid layer of surface water may seriously limit the effectiveness of visual predators.

DISTRIBUTION, DENSITY, and utilization patterns of seabirds occurring along the British Columbia coast are only broadly defined, based on general distributional accounts (Munro and Cowan 1947). Specific accounts have emphasized breeding distributions (Drent and Guiguet 1961, Summers 1974), but a few have discussed the nonbreeding ecology (Martin and Myres 1969, Richardson 1971). This study expands on this data base by providing specific information on the seabirds of the pelagic environment of the Strait of Georgia. *Pelagic* has been defined here as waters overlying depths of 10 fathoms or more.

The Strait of Georgia comprises large stretches of open water (the subject of this study) and also extensive narrow passages and channels protected by the Gulf Islands and Vancouver Island (Figure 1). In the southern half of the strait the approximate width of the pelagic zone varies from 27 km between Bowen and Gabriola Islands to 16 km near the international border. Important adjacent areas include the mud flats of the Fraser River delta, and the Gulf Islands. The flats extend out into the strait as far as 6 km in some places and in winter are used extensively by snow geese, ducks (Taylor 1974), and gulls (Ward 1973). The Gulf Islands form the western border of the pelagic zone, and comprise a major seabird wintering area (Robertson 1978). Here waters shallower than 10 fathoms do not extend into the strait more than a few hundred meters. A detailed account of the oceanography of these waters has been provided by Tully and Dodimead (1957).

The purpose of this study was twofold. First, I wanted to confirm an impression gained during earlier crossings of the Strait of Georgia that very few seabirds occurred in its pelagic waters. Second, I felt it was important to collect seabird data in a habitat that had been recently investigated for biological productivity (Parsons et al. 1970). Thus, in early 1972 I started systematically to record seabirds whenever I crossed the strait by boat. The aim of these observations was to estimate the density of seabirds utilizing the pelagic waters of the strait, identify the species observed, and evaluate the type of utilization involved. Further, I wanted to compare the results with those obtained

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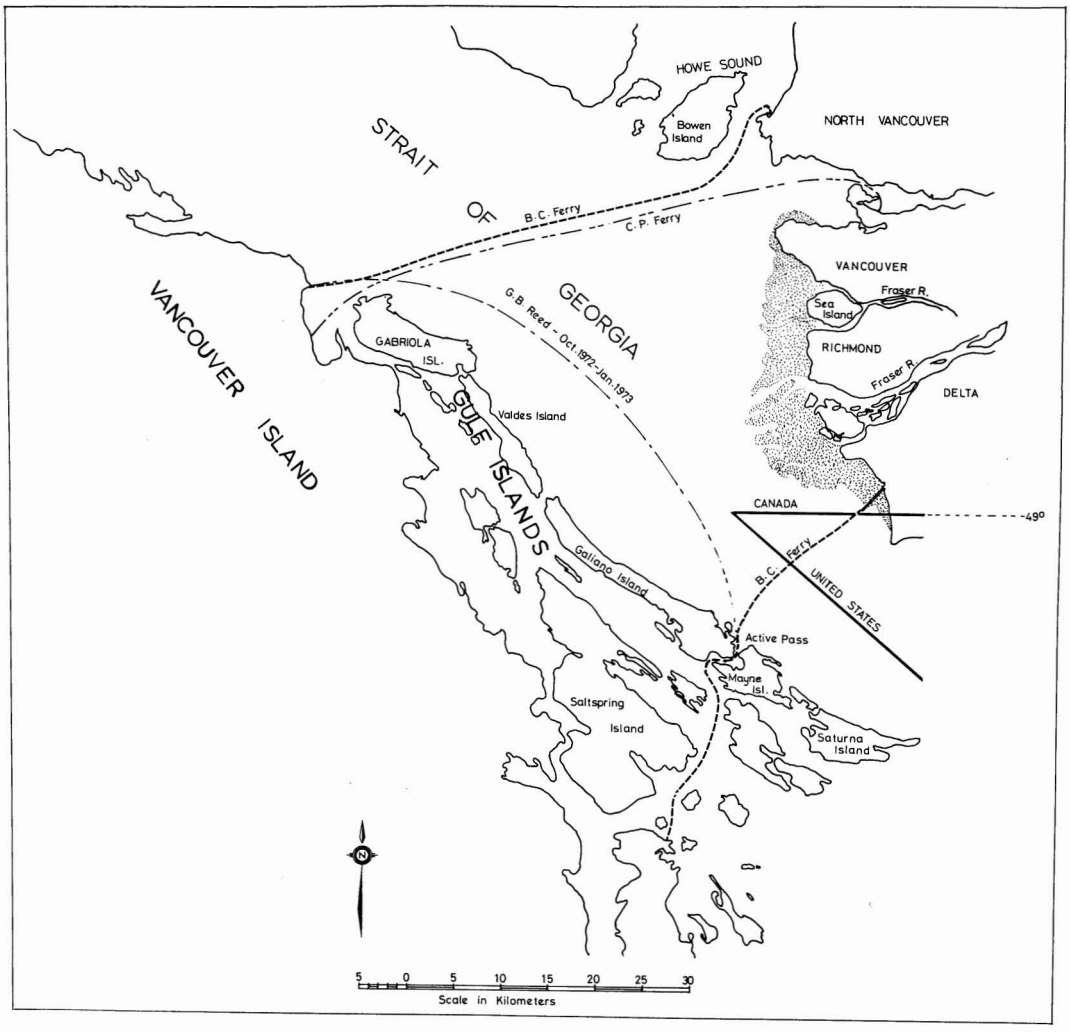

FIGURE 1. The southern half of the Strait of Georgia indicating the boat routes from which observations were made.

during simultaneous observations in the adjacent waters of the Gulf Islands (Robertson 1978), and in the pelagic waters off the west coast of Vancouver Island (Robertson, unpublished data).

METHODS

Between 1972 and 1975 I conducted 25 transects: 21 from the decks of ferries that regularly cross the Strait of Georgia, and 4 from the research vessel G. B. Reed. They were conducted throughout the year and covered routes indicated in Figure 1. Bird observations were recorded in terms of species, number, and behavior (flying, swimming, or foraging). Ship-following birds were distinguished and excluded from the analysis.

From the bird numbers and an estimate of the area surveyed (transect length × transect width) the density of seabirds (birds per km^2) was calculated. Transect length was determined from a combination of vessel speed and time elapsed. Transect width was a function of my effective visual range (Sanger

TABLE 1

SEASONAL VARIATION IN NUMBERS, SPECIES COMPOSITION, AND DENSITY OF SEABIRDS RECORDED IN THE PELAGIC ENVIRONMENT OF THE STRAIT OF GEORGIA

SPECIES	DEC–FEB	MAR–MAY	JUN–AUG	SEPT–NOV	TOTAL
Arctic Loon (*Gavia arctica*)	1	5	1	3	10
Red-necked Grebe (*Podiceps grisegana*)		1			1
Brandt's Cormorant (*Phalacrocorax penicillatus*)	2				2
Double-crested Cormorant (*Phalacrocorax auritus*)			6		6
Pelagic Cormorant (*Phalacrocorax pelagicus*)			1		1
Cormorant sp.	5			1	6
Black Brant (*Branta nigricans*)		55			55
Goldeneye sp.		1			1
Oldsquaw (*Clangula hyemalis*)	1				1
White-winged Scoter (*Melanitta deglandi*)		3			3
Surf Scoter (*Melanitta perspicillata*)	2	8			10
Black Scoter (*Melanitta nigra*)		2			2
Glaucous-winged Gull (*Larus glaucescens*)	17	7	15	2	41
Herring Gull (*Larus argentatus*)				1	1
Thayer's Gull (*Larus thayeri*)	3				3
California Gull (*Larus californicus*)			3	7	10
Mew Gull (*Larus canus*)	55	8		5	68
Large gull sp.	38	9		13	60
Bonaparte's Gull (*Larus philadelphia*)		1	3	71	75
Common Murre (*Uria aalge*)	6	1		8	15
Marbled Murrelet (*Brachyramphus marmoratus*)	2				2
Ancient Murrelet (*Synlithboramphus antiquus*)	1				1
Small alcid sp.	14	1			15
Rhinoceros Auklet (*Cerorhinca monocerata*)				1	1
Total	147	103	28	112	390
Area surveyed (km^2)	30.02	38.67	24.84	28.36	121.89
Density (seabirds per km^2)	4.90	2.66	1.13	3.95	
Average annual seabird density = 3.16 seabirds per km^2					

1972). With 9 × 36 binoculars this was estimated at approximately 500 meters, designated standard transect width, except when poor weather limited my visibility.

RESULTS

The results show that seabird densities in the pelagic environment of the Strait of Georgia were very low. The average annual density recorded was only 3.16 seabirds per km^2 (Table 1). In comparison, an average of 21.60 seabirds per km^2 was recorded in pelagic waters off the west coast of Vancouver Island (Robertson, unpublished data) and 131.27 seabirds per km^2 were recorded in winter in the waters of the Gulf Islands (Robertson 1978). Though seabirds were relatively absent in the study area, the large number of seabirds nearby eliminates a general absence of seabirds in the southern coastal waters of British Columbia as an explanation.

Seasonal variation in numbers was considerable, with winter densities four times greater than those of summer (Table 1). Low numbers in summer also characterize the annual seabird pattern studied by Edwards (1964) in nearby Active Pass. This pattern appears to be general in the protected marine waters of British Columbia.

The species composition was typical of inshore protected waters, but predictably included a high proportion of pelagic-feeding fish and plankton-eating birds, and a low number of waterfowl species (Table 1). Very few species characteristic of the oceanic zone off the west coast of Vancouver Island were recorded.

Gulls, mainly Bonaparte's, Mew, and Glaucous-winged, comprised the largest proportion (66.1 percent) of seabirds recorded. The last named species may have been the most common, but it was difficult to distinguish except at close range from the similar but less common Herring and Thayer's Gulls. This explains the large proportion of unidentified large gulls. Of the remaining seabirds, divers (loons, grebes, cormorants, and alcids) comprised 15.4 percent, Black Brant 14.1 percent, and diving ducks 4.4 percent.

Habitat utilization could not be identified with much precision. In spite of this, the observations confirm the minimal attractiveness of the study area to seabirds. The majority (56.2 percent) of seabirds were flying. Most of these were gulls crossing the Strait of Georgia. Another conspicuous though smaller group comprised waterfowl flying parallel to the shoreline, presumably on migration.

Foraging birds were much less common (22.3 percent), and all but one were feeding in convergent tidal fronts. These fronts are known to concentrate certain pelagic organisms. Data from a study in the English Channel indicates that crustacea were 75 times more common within samples taken from convergent tidal fronts than outside (Pingree et al. 1974). These fronts appeared to be the only feature of these waters (other than boats) that attracted seabirds.

Swimming birds comprised only 21.5 percent of those recorded. A large proportion of these were resting gulls swimming in the wake of ferries.

DISCUSSION

The main conclusion from these observations is that the seabird utilization of the pelagic environment in the Strait of Georgia is minimal and the ecological role of seabirds does not appear to be significant. Compared with other waters along the southern coast of British Columbia the low seabird densities are exceptional.

An anomalous feature of the results obtained is that the biological productivity of the study area is not low. Recent studies have shown it is comparable to other inshore waters of the same latitude (Parsons et al. 1970) and supports important concentrations of primary and secondary consumers (LeBrasseur et al. 1969, Parsons et al. 1969). Simultaneously with the present study it was found that the high densities of fish-eating birds in the Gulf Islands rely to a great extent on adult herring, *Clupea harengus* (Robertson 1978). Although the Strait of Georgia supports important fisheries, information collected annually by the Fisheries and Marine Service of Canada using echo sounding equipment indicates that very few herring occur in the open waters of the strait (L. A. Webb, unpublished data). This offers an explanation for the low number of fish-eating birds in the study area. It also tends to confirm an observation made by Bailey (1966), referring to the seabirds of the southeast coast of Arabia, that food availability is more directly related to seabird numbers than the more trophically remote parameter of biological productivity.

The absence of oceanic species is curious, and was not explored in this study. Possible factors are food availability and ecological barriers.

One additional factor might influence seabird concentrations in the pelagic environment of the Strait of Georgia. The discharge of the Fraser River creates a surface layer of low-salinity turbid water (Tully and Dodimead 1957). This plume frequently extends across the strait as far as the Gulf Islands. The associated turbidity, which appears to be highest during the late spring and early summer, could limit the effectiveness of visual predators like birds, and thus make prey unavailable. If this is a general phenomenon in turbid estuaries, low seabird densities should be found in similar habitats.

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